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OSTEOLOGY OF ORNITHOPODOUS DINOSAURS FROM THE DINOSAUR NATIONAL MONUMENT, UTAH.

BY CHARLES W. GILMORE.

Part I. On a Skeleton of *Camptosaurus medius* Marsh.
Part II. On a Skeleton of *Dryosaurus altus* Marsh.
Part III. On a Skeleton of *Laosaurus gracilis* Marsh.

(PLATE XVIII.)

INTRODUCTION.

Three partly articulated skeletons pertaining to the Ornithischian genera *Camptosaurus*, *Dryosaurus*, and *Laosaurus*, in the paleontological collection of the Carnegie Museum, are of unusual interest in that they furnish information concerning the skeletal anatomy of these genera, which has long been obscure, if not previously unknown.

All three of these specimens were collected by Mr. Earl Douglass and his assistants from the famous Dinosaur National Monument Quarry, discovered by Douglass in 1909, near Jensen in northeastern Utah.

The present paper gives the results of a study of these specimens.

Part I. ON A SKELETON OF CAMPTOSAURUS MEDIUS MARSH.

Since the skeletal anatomy of the genus *Camptosaurus* has been set forth in considerable detail in a previous paper[1], it seems only necessary at this time to supplement that description by such new features as are disclosed by a study of a partially articulated skeleton of *Camptosaurus medius* (No. 11,337, Carnegie Museum).

[1] Gilmore, C. W., Proc. U. S. Nat. Mus., vol. 36, 1909, pp. 197–332.

The skeleton, consisting of the greater portion of the articulated back-bone and ribs, together with the more or less disarranged limb and pelvic bones, was received at the Museum in a single large block of sandstone. The vertebral column with attached ilia and ribs has been worked out in relief, while the slightly displaced limb and pelvic elements, with the exception of the left fore limb and foot, have been entirely extracted from the matrix. The skeleton is lying on its right side with the neck curved strongly backward above the anterior dorsal region (See Plate XVIII). The vertebral column is completely articulated from the axis back to the fourteenth caudal vertebra. This is the first camptosaurian specimen discovered, in which the complete presacral series can be positively determined. The ribs are distended, a few slightly disarranged, but nearly all are articulated with their respective vertebræ. None of the disturbed bones were far removed from the vertebral column in the rock, and since this was the only small dinosaurian specimen found in this part of the quarry there is no reason for not regarding all of the associated bones as belonging to a single individual.

The following bones of the skeleton are present: eight cervicals; seventeen dorsals; five sacrals; thirteen caudals; both ilia; both pubes; both ischia; both scapulæ; left coracoid; both humeri, left radius, ulna, carpus, and manus; both femora; both tibiæ; both fibulæ; thirty-one thoracic ribs (several incomplete); three posterior cervical ribs; two chevrons, and ossified tendons. The important parts missing are the skull, atlas, hind feet, a few anterior cervical ribs, chevrons, and the distal half of the tail.

The medium size of the specimen together with characters found in the pelvis, such as the vertical narrowness of the ilium, with shortened oblique border of the supero-posterior end, the general slenderness of the ischia with moderately expanded distal extremities, indicate that this specimen should be assigned to the species *Camptosaurus medius* Marsh.

Camptosaurus medius Marsh.

Camptosaurus medius Marsh, Amer. Jour. Sci. (3), vol. 48, 1894, p. 85, pl. III.

The status of this species is not altogether satisfactorily established, and it never can be until the type has been fully prepared and described. Although based on an adequate specimen, Marsh's original description consisted of a few lines without definition, accompanied by figures of the skull. In revising the genus in 1909,[2] *C. medius* was retained as a valid species and an attempt was made to characterize it. Owing to the unprepared state of the greater portion of the type materials, which were studied at that time, the results obtained were far

[2] *Op. cit.*

from satisfactory. Attention was called to the composite nature of the illustrated skull, and the statement made that it could not be relied upon for specific differentiation.

At present the species rests upon its intermediate size and characters found in the pelvic bones. In my previous study of this species it was anticipated that other and more important specific characters might be disclosed by a study of the other portions of the type specimen, when they should become available. I am not so sure of that now. A study of the excellently preserved skeleton now before me, of the proper size and with a pelvis typically like *C. medius*, fails to reveal any differences in the other parts of the skeleton which can be regarded as of specific importance.

If a similar condition is eventually found in the type specimen, it will certainly permit the suggestion that perhaps after all the observed differences represent sexual characters only, and that *C. medius* may be the female of one of the larger species of the genus.

Description of Specimen No. 11,337, C. M. Cat. Vert. Foss.

Vertebral column:—The articulated presacral series in the specimen now before me consists of 25 vertebræ, commencing with the axis and continuing backward in sequence to include the vertebra usually designated as the sacro-dorsal. This articulated series has a total length of about 1206 mm. of which the cervicals contribute 391 mm. The first eight vertebræ are regarded as belonging to the neck. The point of division between cervical and dorsal series is marked by the sudden transposition of the capitular facet from the anterior lateral surface of the centrum on cervical nine to a point well up on the side of the arch beneath the transversely extended and strongly developed diapophysis on the succeeding vertebra. Thus it is positively shown, for the first time that the dorsal series series consists of 17 vertebræ. It now becomes necessary to amend the vertebral formula as formerly determined by me in 1909,[3] by the addition of one more dorsal making 17 in all. The vertebral formula will now stand as follows: Cervicals–9; dorsals–17; sacrals–4 or 5; caudals–44+.

In the European representative of this group, *Igaunodon bernissartensis*, Dollo[4] recognizes 9 cervicals, 17 dorsals, and 1 lumbar, a total of 27 presacrals or one more than in *Camptosaurus*.

[3] *Op. cit.*, p. 224.

[4] Bull. Bruxelles. Mus. Roy, d'Hist. Nat. de Belgique, vol. 2, 1883, p. 245.

It may be that the vertebra here designated as sacro-dorsal (Plate XVIII, *d*17) does not bear a rib and in that event lumbar would be the more appropriate designation. In this specimen the diapophysis of the left side has been freed from the matrix, but no trace of a rib was found, although the vertebræ preceding it are all articulated with double-headed ribs. If present, the rib carried by this vertebra would be single-headed, as shown by the disappearance of the capitular facet. The suspected presence of a single-headed rib presents nothing new in dinosaurian anatomy, as *Thescelosaurus neglectus* Gilmore[5] from the Upper Cretaceous has no less than four single-headed ribs preceding the sacral series, and the closely related *Dryosaurus* (See p. 400) also has a posterior single-headed rib.

In the present specimen there are five vertebræ, which are strongly joined to the ilia, and, while these are all regarded as belonging to the sacrum, it is quite evident that the posterior one is a modified caudal. It has a shortened centrum that is not suturally united with the centrum preceding it. The other sacrals, including the sacro-dorsal, have their centra suturally united, though none have become coalesced. This feature, including the distinct neurocentral sutures of the presacral series, clearly indicates the immaturity of the individual. The five sacral vertebræ have a combined length of 243 millimeters. I am unable to determine whether the centra were joined by the peg-and-notch articulation, which is so characteristic of *Camptosaurus dispar* Marsh and present to a less degree in *C. browni* Gilmore. The other features of the sacral vertebræ are not to be observed in this specimen, since they are either covered by the overlying ilium or remain buried in the matrix.

There are thirteen anterior caudal vertebræ articulated in sequence with the sacrum. The first shows a distinct chevron-facet, and, although the chevron-bone is missing, it is quite evident that this vertebra bore the first of the series, whereas in *C. nanus* and *C. browni* the first chevron is carried on the second caudal[6] and this is apparently the condition found in *C. dispar*, as clearly indicated in Marsh's restoration[7] of that species. Flattened transverse processes are present on the first eleven vertebræ counting from the sacrum, whereas in *C. browni*, and *C. dispar* they continue backward to the twelfth and thirteenth caudals respectively. It would appear that the distal extent of these processes vary with the individual and therefore do not constitute a specific distinction.

[5] Proc. U. S. Nat. Mus., vol. 49, 1915, p. 609.

[6] Proc. U. S. Nat. Mus., vol. 36, 1909, p. 239.

[7] 16th Ann. Rept. U. S. Geol. Surv. for 1894–95, pt. 1, 1896, pl. 56

A comparison of the vertebræ of *Camptosaurus medius*, as represented in the Carnegie Museum specimen, with those of the other described species, insofar as they can be compared, fails to disclose any specific differences, except their intermediate size.

Ribs:—The importance of the present specimen is further emphasized by the presence of nearly all of the thoracic ribs, 31 in all, the greater number remaining articulated with their respective vertebræ. This is the only specimen known at this time, which gives absolute information as to the proper sequence of the dorsal ribs, and it will hereafter be the standard for interpreting and coördinating the scattered and isolated ribs of others of its kind.

All of the ribs with the exception of the last (if the seventeenth dorsal bears a rib) are double-headed. The first is hardly more than an attenuated cervical rib, without distal expansion, and probably not connected with the sternum. It has a greatest length of 160 mm., measured from the tuberculum. The second rib is progressively longer and more robust, and also without distal expansion. The ends of this pair of ribs are incompletely preserved, but from the taper of the shaft it is quite apparent that it was pointed. Its shaft is more curved than the first and the articular end has assumed the shape of the more typical ribs of the median thoracic series (See Plate XVIII). In all probability it was not joined to the sternal plates. The third, however, is developed into a fully shaped thoracic rib having a truncated slightly expanded distal end, which unquestionably articulated with a cartilaginous rib. The center of the rib is flattened, but the lower half is more rounded than those succeeding it. The fourth, fifth, and sixth are about subequal in length, the longest and heaviest of the series. It was previously thought from fragmentary evidence that the seventh dorsal rib was the heaviest, but in this specimen the fifth has that distinction. The shafts are flattened, broad, with a strong median longitudinal swelling on the external side toward the distal end. The ribs posteriorly become progressively shorter, with a gradual narrowing of the shaft, and the flattened branch carrying the capitulum of the anterior ribs becomes more rounded. The space between the capitulum and tuberculum gradually shortens and the tuberculum is gradually reduced to a small and very weak articular attachment. The posterior members of the series which lie within the forward processes of the ilia are directed strongly forward. Unfortunately the distal ends of all the posterior half of the series are incomplete and their precise length cannot be determined.

That *Camptosaurus* had a broad, rounded back is clearly indicated by the strong curve of the ribs beyond the transverse processes with which they articulate.

Shoulder-Girdle, Fore Limb, and Foot:—Both scapulæ and one coracoid are all that remains of the pectoral arch. Fortunately the right scapula (See Plate XVIII) has been retained in the position in which it was found and gives the first evidence of the proper position and relative angulation of the shoulder blade, thus defining the chest. The horizontal position of the scapula in the hadrosaurian dinosaurs has long been established upon the evidence of numerous specimens having these bones preserved in position. It is, therefore, of interest to find in the bipedal *Camptosaurus* a somewhat similar position of the scapula, as shown in Plate XVIII. It is shown by this specimen that these bones are incorrectly articulated in the three mounted skeletons of this genus now exhibited in the American Museum of Natural History and in the United States National Museum.[8] The blade has a more horizontal position on the sides of the ribs, though not so extreme in this respect as in the Hadrosauridæ. Viewed from the side, the upper or distal extremity falls below the level of the vertebral centra in the articulated skeleton, and the truncated distal end reaches a point slightly posterior to the fifth rib. In this position the anterior or proximal end falls below the first dorsal, instead of the posterior cervicals, as in the mounted skeletons mentioned above.

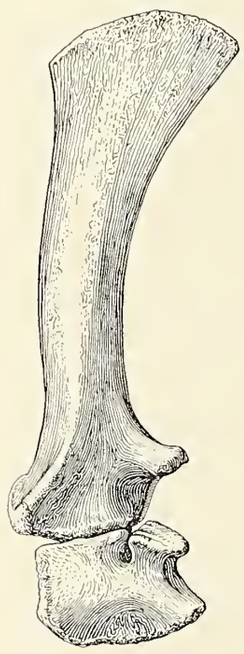


Fig. 1. Left scapula and coracoid of *Camptosaurus medius* Marsh (No. 11,337 C. M. Cat. Vert. Foss.), viewed from the side. One-fourth natural size.

The left scapula, as shown in figure 1, is perfectly preserved and presents an outline of the upper extremity of the blade somewhat different from that found in *C. browni* and *C. nanus*. This scapula has a greatest length of 290 mm. with a greatest breadth of the expanded blade of 117 mm. In the articulated skeleton as found it was pushed out of its proper position as clearly shown in Plate XVIII.

The articulated left fore limb, carpus, and foot are beautifully preserved, as shown in figure 2. The strong flexure of the elbow-joint is indicated and also the fact that in the hanging pose of the fore legs, when walking erect on the hind limbs, the palms of the feet would be directed strongly toward one another. The carpus and foot are complete, except for the loss of the ungual phalanx of digit III. It agrees in every particular with the described[9] foot of *Camptosaurus dispar*, except for its smaller size.

[8] Proc. U. S. Nat. Mus., vol. 36, 1909, pl. 19; vol. 41, 1912, pls. 56, 57.

[9] Proc. U. S. Nat. Mus., vol. 36, 1909, pp. 251–256.

The importance of the present limb and foot lies in its verification of the structure of previously described fore feet, and the more accurate information furnished regarding the proper articulation of the bones at the elbow-joint, so clearly demonstrated in figure 2.

The compact ossified carpus, with smooth, well defined articulating surfaces for the radius and ulna, short and stout metacarpals, are indicative of a foot, the function of which was for support, rather than for use as a grasping or prehensile appendage. It presents a striking contrast to the largely unossified carpus and elongated metacarpus of the bipedal, herbivorous hadrosaurian dinosaurs of the Upper Cretaceous. From a posterior view of the carpus only seven carpal elements can be detected. Three of these form the proximal row, the others represent carpals

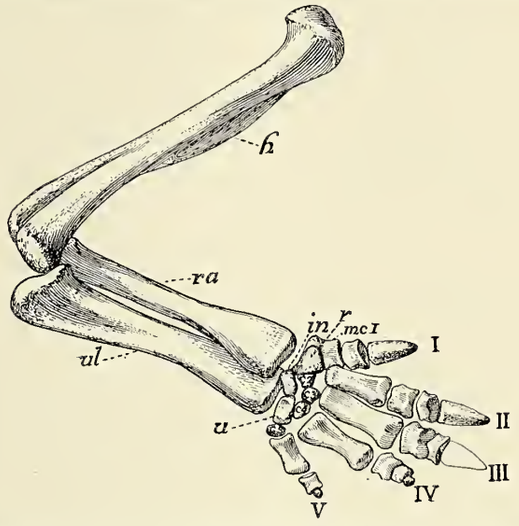


FIG. 2. Left fore limb and foot of *Camptosaurus medius* (No. 11,337 C. M. Cat. Vert. Foss.). One-fourth natural size, viewed from the internal side. The palmar side of the foot is shown. *h*. humerus; *ra*, radius; *ul*, ulna; *r*, radiale; *in*, intermedium; *u*, ulnare; C_2, C_3, C_4, C_5, carpals two to five respectively; *mc* I metacarpal one. I, II, III, IV, V, digits one to five.

two, three, four, and five of the distal row. Carpal one, as known from other specimens, is not visible from a posterior aspect of the foot.

The humerus, radius, and ulna, except for their intermediate size, show no characteristics distinguishing them from the homologous elements of the other described species.

Pelvic Girdle and Hind Limbs:—Both ilia remain attached to the sacrum, but only the left is available for comparison, and it has suffered the loss of portions of the anterior and posterior extremities. With our present knowledge of the *Camptosauridæ*, this is one of the few characteristic bones of the skeleton. The proportions of the ilium are of the narrow depressed type found in *Camptosaurus medius* and *C. browni*, which reached its extreme development in *C. depressus*.

The narrowness of the ilium above the acetabular border as compared to its length, the relatively narrow preacetabular notch, and the apparently short oblique supero-posterior border are in close accord with the ilium of the type of *Camptosaurus medius*, and these features at once distinguish it from the ilia of *C. dispar*, and *C. nanus*. From *C. browni*, however, except for its smaller size, the distinction is not so clearly established.

The prepubis is relatively shorter than in the type of *C. medius* with a more squarely truncated end. The postpubic portion is long, slender, and terminates with slight expansion of the distal end. The pubic foramen exists as a notch, whereas in the type it is entirely inclosed, but this is probably a characteristic of age.

The ischium agrees perfectly with the type of the species in being slender, with a small distal hammer-like expansion, as contrasted with the more robust development in *C. dispar* and *C. browni*.

The bones of the hind limbs, except for their smaller size, show no distinctive features, and, since these elements of *Camptosaurus* have been fully described, it appears unnecessary to mention them further at this time.

Summary

The important facts determined from a study of this well preserved and partially articulated specimen may be summarized as follows: *First*, that the complete presacral series in *Camptosaurus* consists of twenty-six vertebræ; *second*, that the most posterior presacral may not bear ribs and should therefore be considered a lumbar as in *Iguanodon*; *third*, that the third thoracic rib is the first one of the series to be attached to the sternum; *fourth*, that the first caudal carries the first chevron; *fifth*, that the scapula assumes a more horizontal position and occupies a lower and more posterior place on the side of the ribs than has been given it in articulated skeletons; *sixth*, that while the manus can be rotated into other positions, the normal hanging pose would be with the palms of the hands directed strongly toward one another.

Six species of *Camptosaurus* have been described from North America: *C. dispar*, *C. medius*, *C. amplus*, and *C. nanus* by Marsh; *C. browni* and *C. depressus* by Gilmore. The genotype, *C. dispar*, is satisfactorily established; *C. nanus* is a good species, distinguished at once by its small size; *C. medius*, the type of which yet remains to be fully described, appears to be a distinct species, distinguished at present by characters found in the pelvis, which with its smaller size and slenderer structure, permit the suggestion that it may eventually be found to represent the female of the larger *C. dispar*, and that its fully adult development may be represented in *C. browni*. While for the present it may be well to retain the last men-

tioned species, after several years reflection and with a wider knowledge of dinosaurian anatomy, I am inclined to the opinion that no good reason ever existed for its establishment. *C. amplus* at present is distinguished by its very large size. *Camptosaurus depressus*, although founded on a rather poor specimen, is probably justified on the ground of its geological occurrence in the Lakota formation.

That the present specimen, here attributed to *Camptosaurus medius*, is not fully adult is abundantly indicated by the distinct sutures and especially by the noncoalescence of the sacral vertebræ. This immature condition may account for the intermediate proportions of the animal, as is so clearly demonstrated in the table of comparative measurements which follows:

Comparative Measurements	*Camptosaurus nanus* Type, 2210, U. S. N. M.	*Camptosaurus medius* No. 11337, Carnegie Mus.	*Camptosaurus browni* Type No. 4282, U. S. Nat. Mus.	*Camptosaurus dispar* Type No. 1877, Yale Mus.	*Camptosaurus dispar* Paratype, No. 1877a, Yale Mus.
	mm.	mm.	mm.	mm.	mm.
Pectoral Girdle and Fore Limbs:					
Scapula, length	187	290e	482	–	–
Scapula width, widest portion of blade	59	117	175	–	–
Coracoid, length	35	68	115	–	–
Humerus, length	143	227	360	337	–
Ulna, length	102	160	262	260	–
Radius, length	45	143	232	245	–
Metacarpal I, length	–	10	–	–	–
Metacarpal II, length	–	35	–	–	–
Metacarpal III, length	–	45	–	–	–
Metacarpal IV, length	–	41	–	–	–
Metacarpal V, length	–	22	–	–	–
Pelvic Girdle and Hind Limbs:					
Ilium, length	244	400e	618e	–	–
Ilium, vertical height above middle of acetabulum	45	70	115	–	132
Pubis, length	–	224	–	–	348
Pubis, width of preacetabular expansion	–	55	–	–	72
Pubis, length of postacetabular process	–	320	–	–	528
Ischium, length	–	380	545	–	600
Ischium, greatest width of distal end	–	50	79	–	96
Femur, length	258	395	–	565	–
Tibia, length	235	360	–	555	–
Fibula, length	207	320	–	–	–
Sacrum, combined length of 4 sacral centra	126	200	288	323	–
Neck, length of combined nine cervicals	206e	391e	–	565	–

e = estimated.

Part II. On a Skeleton of Dryosaurus altus Marsh.

A partly articulated skeleton (No. 3,392, C. M. Cat. Vert. Foss.) is identified as belonging to *Dryosaurus altus* Marsh.

This specimen is not yet fully prepared, but the skeletal parts available for study contribute so much to a better understanding of this little known form, that it seems advisable to describe it in advance of its complete preparation.

At present the skeleton is in three principal sections. The skull and lower jaw, articulated with the first five cervical vertebræ, constitutes the first section; the second consists of an articulated series of seven anterior dorsal vertebræ with the proximal portions of the ribs of both sides in position, together with the right scapula, coracoid, and humerus; the third is made up of six posterior dorsal vertebræ articulated with the sacrum, and portions of the pelvic arch. In addition the proximal third of the right femur, proximal end of the right tibia, one complete metatarsal and distal portions of two others have been completely freed from the rock. The articulated left hind foot, with some of the limb and other identified bones, still remain unprepared in a block of sandstone.

Dryosaurus altus Marsh.

Laosaurus altus Marsh, Amer. Jour. Sci. (3) vol. 16, 1878, pp. 415–416, pl. IX.
Dryosaurus altus Marsh, Amer. Jour. Sci. (3) vol. 48, 1894, p. 86.

The genus *Dryosaurus* was established by Marsh on the type of the species *Laosaurus altus*. At the time of publishing the original description, a tooth, the articulated pelvis, hind limb, and foot were figured. These are the only bones of the type material which have ever been illustrated, and in the many years which have intervened since its establishment, nothing further has been contributed to our knowledge of this genus and species. The brief original description, characterization of the genus, and illustrations were republished by Marsh in various places, but there were no additions and but few emendations. It is, therefore, of great interest to find a specimen in the collections of the Carnegie Museum which contributes to a further elucidation of its skeletal anatomy.

The final characterization of the genus *Dryosaurus* by Marsh[10] is as follows:

> Premaxillaries edentulous with horny beak. Teeth of moderate size. A supraorbital fossa. Cervicals long and biconcave. No lumbars. Six ossified vertebræ in sacrum, without peg and notch articulation. Sternum unossified. Limb bones hollow. Forelimbs very small. Five digits in manus. Prepubis long and narrow; postpubis elongate and slender. Posterior limbs very long. Femur shorter than tibia. Metatarsals long and hollow. First digit in pes complete; fifth metatarsal represented by short splint only.

[10] 16th Ann. Rept. U. S. Geol. Surv., pt. 1, 1896, p. 201.

The above definition, when compared with that given by the same author[11] for the closely allied genus *Laosaurus*, shows but two important distinctions, *i. e.* "cervicals long and biconcave" as contrasted with "cervicals short and flat," and "prepubis long and narrow" as opposed to "prepubis very short and pointed."

A comparison of *Dryosaurus* and *Laosaurus* specimens in the Carnegie Museum unfortunately does not permit of a verification of these characters. On the other hand they show such close resemblances in skull and other features as to raise the question of their generic distinctness. It remains, therefore, for the type specimens in the Yale Museum to be fully prepared and described before judgment can be passed on the query here raised. Should it be shown that these two genera are not distinct, *Dryosaurus* would become a synonym of *Laosaurus*, which has priority by several years.

The large size of the present individual, larger than any described species of *Laosaurus*, the presence of a relatively long prepubis (though incomplete), and other lesser features are in accord with Marsh's definition and illustrations of *Dryosaurus altus*, the genotype, and for these reasons it is so referred.

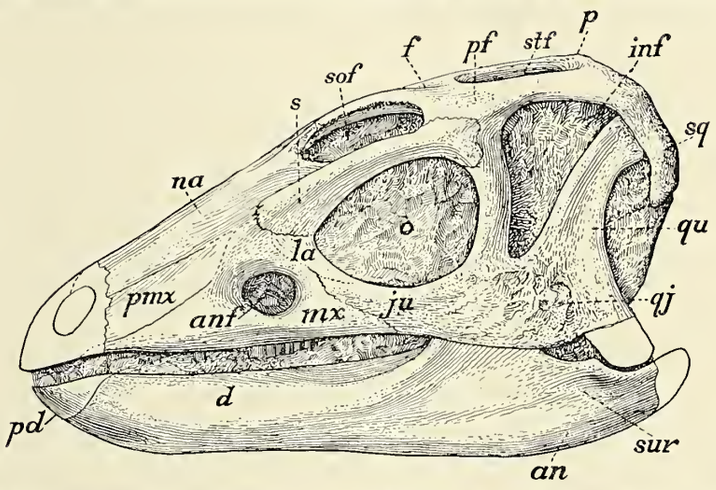


Fig. 3. Skull of *Dryosaurus altus* Marsh. No. 3,392 C. M. Cat. Vert. Foss. Viewed from the left side. One-half natural size. Slightly restored after *Laosaurus*. *anf*, anteorbital fossa; *an*, angular; *d*, dentary; *f*, frontal; *inf*, infratemporal fossa; *ju*, jugal; *la*, lachrymal; *mx*, maxillary; *na*, nasal; *o*, orbit; *p*, parietal; *pd*, predentary; *pf*, postfrontal+postorbital complex; *pmx*, premaxillary; *qj*, quadratojugal; *qu*, quadrate; *s*, supraorbital; *sof*, supraorbital fossa; *sq*, squamosal; *stf*, supratemporal fossa; *sur*, surangular. Unknown or obscure sutures are indicated by broken lines; restored parts are unshaded.

Description of No. 3,392, C. M. Cat. Vert. Foss.

The Skull:—In the specimen now before me the left side of the skull and lower jaws are preserved. They are little distorted by crushing and give for the first time a very clear conception of the lateral profile of the skull. In figure 3, is

[11] *Loc. cit.* p. 201.

shown a side view of this skull and lower jaws. Slight corrections have been made where distortion was apparent, and some restoration was necessary where parts were missing or obscure in the specimen.

Viewed from the side (See fig. 3), the skull of *Dryosaurus* with the jaw in position is relatively short, bluntly pointed in front, moderately high behind, and with a large subcircular orbit. The orbit is about one-fourth the total length of the skull and is placed well toward its middle. The infratemporal fossa is subtriangular in outline with the apex directed ventrally.

Especially noteworthy is the presence of a large enclosed supraorbital fossa, and a relatively large anteorbital foramen or fossa, which lies wholly within the maxillary bone. Marsh[12] recognized the presence of a supraorbital fossa in the *Dryosaurus* material studied by him, but that is about the only mention made of cranial characters. In Marsh's restoration[13] of the skeleton of *Laosaurus*, the skull is depicted, but how much of this figure is based on actual cranial materials and how much is conjectural has never been stated. If the restored skull of *Laosaurus* is well founded, it furnishes important characters for the more distinct separation of these two closely allied genera. When compared with the *Dryosaurus* skull now before me, many differences are to be observed, so that at this time I have grave doubts of its authenticity.

The supraorbital bar, which forms the external boundary of the supraorbital fossa, is relatively heavy, and presents a striking contrast to the slenderer and incomplete bar found in the allied *Camptosaurus*.[14] This bar in *Dryosaurus* is probably formed by two supraorbital bones, an anterior and a posterior, which have coalesced where they meet above the orbit. In *Iguanodon bernissartensis*, Dollo has found two such elements, but up to this time only an anterior supraorbital bone has been recognized in *Camptosaurus*.

The lateral fenestra in the maxillary, so far as I can discover, has not before been observed in a member of the American Ornithischia. A small anteorbital vacuity is present in *Iguanodon*. A skull of *Laosaurus gracilis*, which I shall presently describe, has a similar fossa, but none was shown in Marsh's restoration of the skull and skeleton of *Laosaurus consors* mentioned above. If at all comparable with the lateral fenestra of the theropod skull, it would represent the second anteorbital fenestra, which in those forms also lies wholly within the maxillary bone. It certainly is not to be correlated with the first, as that opening is always bounded posteriorly by the lachrymal. Slight displacement of the left maxillary, which

[12] Amer. Jour. Sci. (3) vol. 48, 1894, p. 88.

[13] 16th Ann. Rept. U. S. Geol. Survey, Pt. I, 1896, Pl. 57.

[14] Gilmore, Charles W., Proc. U. S. Nat. Mus., vol. 36, 1909, figs. 2 and 3.

apparently follows the lines of sutural contact, clearly discloses the outline of this as well as of a few other cranial elements, but for the most part they cannot be certainly delimited. Whenever in doubt, the cranial sutures in the restored skull (See fig. 3) have been indicated by broken lines.

The quadrate curves strongly backward as in *Camptosaurus*. Superiorly it articulates with the squamosal, but the distal portion is so poorly preserved that its features can not be observed. It has been restored after the quadrate of the *Laosaurus gracilis* (No. 11,340, C. M. Cat. Vert. Foss.) described in the present paper on pp. 403–409.

The squamosal is strongly produced backward and downward behind the top of the quadrate, forming the whole of the outer postero-superior angle of the skull. Whether a portion of this hook-like projection may be a part of the outer end of the paroccipital process cannot be determined.

Enough remains of the frontal region to show that it was broad and flat between the supraorbital fossæ. The upper parietal surface closely resembles that of *Camptosaurus* in being narrow between the supratemporal fossæ. The sutural contacts of this aspect of the skull cannot be seen. The lateral border of the frontal is higher above the orbit than in *Camptosaurus*, and on this account the supraorbital fossa is more conspicuously exposed in a lateral view. It is presumed that the postfrontal and postorbital bones have coalesced to form a complex as in many other dinosaurian genera.

The jugal in lateral view forms a relatively wide bar, especially below the infratemporal fossa. Its narrow contribution to the lower boundary of this fossa is in striking contrast to the much more extensive participation in *Camptosaurus*. In the antero-posterior shortening of the skull posterior to the orbit, *Dryosaurus* resembles the cranium of *Iguanodon*. Presumably the jugal meets the lachrymal anteriorly, but the limits of that bone cannot be differentiated in this specimen.

The form of the maxillary, as mentioned previously, is quite certainly determined, except for its upward extent. It appears to be in contact with the nasal above and to exclude the posterior process of the premaxillary from contact with the prefrontal.

The premaxillary is largely missing, only the posteriorly directed process remains, which is interposed between the forward end of the maxillary and the nasal bones. The nose has been wholly restored, as shown in figure 3.

The left ramus is nearly complete and presents an accurate conception of its size and contour. Unfortunately none of its sutures can be detected, so that this

specimen contributes nothing concerning its more detailed structure. The predentary is present, but badly crushed and broken. Teeth are present in both upper and lower jaws, but their preservation is such that neither their number nor details of structure can be determined.

The principal measurements of the skull and lower jaw are given in the following table:

Measurements of Skull No. 3,393 C. M.

Greatest length of skull, estimated	185 mm.
Distance from posterior border of orbit to extremity of squamosal	58 mm.
Distance from distal end of quadrate to top of skull, estimated	90 mm.
Height of skull with ramus, at posterior end	112 mm.
Height of skull with ramus, taken at center of orbit	103 mm.
Height of skull, taken at center of maxillary	55 mm.
Length of quadrate, estimated	73 mm.
Greatest length of ramus	172 mm.
Antero-posterior diameter of orbit	48 mm.
Vertical diameter of orbit, taken at center	30 mm.
Antero-posterior diameter of supraorbital fossa	36 mm.
Vertical diameter of infratemporal fossa	43 mm.

Vertebræ:—The vertebral column is represented by parts of 24 vertebræ, separated into three articulated series. The neck is represented by five vertebræ articulated with the skull and commencing with the atlas; the dorsal region by seven anterior dorsals and six posterior dorsals, the latter articulated with six vertebræ which comprise the sacrum. Because of their poor preservation it cannot be determined whether the two dorsal series were continuous or not.

The cervicals have not been fully prepared and but little more than an oblique latero-superior view is to be obtained. Insofar as they can be compared they are strikingly like those of *Camptosaurus medius*. The only differences observed are the more slender zygopophyses and the presence of an incipient spinous process on cervicals three and four. These spines are absent in *Camptosaurus*, but Marsh indicates them on the cervicals of *Laosaurus consors* in his restoration of that animal. The atlas remains almost completely hidden in the matrix. The axis, especially the neural spine, is clearly seen, and, while it resembles the spine of the axis of *Camptosaurus*, it differs in having the upper crest more depressed, with a long convex profile, as contrasted with the concave border in that genus. These five cervical vertebræ have an estimated length of 205 millimeters.

The series of seven anterior dorsals is thought to begin with the fourth. If correct in this estimate and if *Dryosaurus* has the same vertebral formula as *Camptosaurus*, there would be but one missing between the two dorsal series. The poor preservation of the vertebræ, however, does not allow of an accurate

determination on this point. The badly crushed condition of the vertebræ, combined with a lack of definition, as to their outline and other details renders an attempted description of but little value. Their principal features are shown in figure 4. The proximal portions of most of the thoracic ribs of both sides remain articulated with their respective vertebræ, as they are in the posterior series. These seven dorsals have an estimated length of about 360 mm.

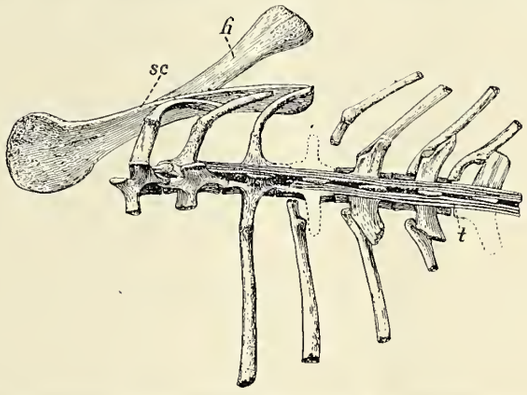


FIG. 4. Anterior dorsal vertebræ with articulated ribs of *Dryosaurus altus* Marsh. Superior view. (No. 3,392, C. M. Cat. Vert. Foss.), about one-sixth natural size. *h*, right humerus; *sc*, right scapula and coracoid; *t*, ossified tendons.

The third series (See fig. 5) may be continuous with the second group described above, but of this one cannot be certain. The preservation of these vertebræ is slightly better than that in the preceding series, but like them only the superior view is available for study (See fig. 5).

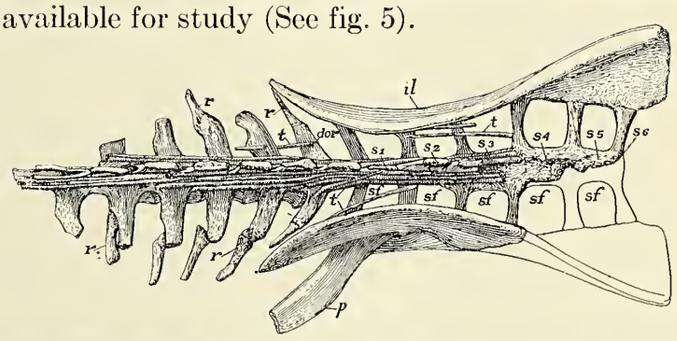


FIG. 5. Posterior dorsal vertebræ, sacrum, and pelvis with articulated ribs of *Dryosaurus altus* Marsh. Superior view. (No. 3,392, C. M. Cat. Vert. Foss.), about one-sixth natural size. *dor*, last dorsal vertebra; *il*, ilia; *p*, prepubis; *r*, ribs; S_1, S_2, S_3, S_4, S_5, S_6, sacral vertebræ one to six respectively; *sf*, sacral foramina; *t*, ossified tendons.

The principal features observed in the posterior presacral series is that all of the dorsals preceding the sacrum bear ribs; the spinous processes grow progressively longer and become wider antero-posteriorly, as the sacrum is approached; the diapophysial, and parapophysial facets gradually approach one another as in *Camptosaurus*; the transverse processes of the last two dorsals are directed

decidedly forward; the posterior dorsal bears a single-headed rib, all others are double-headed; several of the posterior ribs seem to be coössified with the diapophysis, especially the last; the most posterior ribs are directed strongly forward toward the anterior ends of the ilia; the vertebræ are strongly bound together by a series of ossified tendons running along on either side of the spinous processes.

There are six vertebræ articulated with the ilia by short, stout, sacral ribs. These vertebræ may all properly be considered sacral, as originally determined by Marsh, and according to him an equal number is found in *Laosaurus*. Although as many as seven vertebræ have been found united by suture in *Camptosaurus*,[15] never more than five are directly joined with the ilia by their diapophyses and sacral ribs. This feature therefore constitutes an important structural difference distinguishing the *Laosauridæ* from the *Camptosauridæ*. It cannot be determined from the present specimen whether the sacral vertebræ are coössified or not. It is estimated that this series of 12 articulated dorsal and sacral vertebræ have a combined length of about 545 mm.

Pectoral Arch, Fore Limb, and Foot:—The pectoral arch is represented by the right scapula and coracoid, preserved practically in position in relation to the anterior thoracic region, as shown in figure 4.

The scapula and coracoid, insofar as they can be compared, bear a strikingly close resemblance to the homologous bones in *Camptosaurus*. Unfortunately their full outlines cannot be observed due to lack of complete preparation. The complete length of the two bones is about 245 millimeters. The scapula, as in *Camptosaurus medius*, previously described, occupies a more or less horizontal position on the upper anterior side of the thorax, and, if the vertebræ of this second series has been correctly identified as to position in the vertebral column, its upper or distal extremity reaches a point slightly posterior to the fifth rib, as in the skeleton of *Camptosaurus* mentioned above.

The right humerus is retained in the matrix immediately below the scapula, as shown in figure 4. Only the distal half has been prepared, but it has the same antero-posteriorly compressed, straightened shaft found in *Laosaurus*; the obliquely truncated distal end with feebly developed condyles bring especially characteristic. The total length of this bone is 190 millimeters, the same dimensions given by Marsh[16] for the humerus of the type specimen of *Dryosaurus altus*. The distal end has a greatest transverse diameter of 42 millimeters.

A small block of matrix contains a considerable number of the bones of a manus. These elements are somewhat disarranged and their contours are so

[15] Proc. U. S. Nat. Mus., vol. 36, 1909, p. 234, fig. 17.

[16] Amer. Jour. Sci. (3) vol. 16, 1878, p. 415.

poorly defined that their detailed structure cannot be determined. Tentatively the following elements are recognized: the distal end of the radius, below which are several carpal elements; and below the carpus four metacarpals which from left to right have the following lengths: Met. V, 18 mm.; Met. IV, 26 mm.; Met. II, 23 mm.; a few phalangial bones are also present.

Pelvic Arch, Hind Limb, and Foot:—The pelvic arch has the greater portion of the right ilium, the anterior superior half of the left ilium, and the left prepubis preserved. The ilia are in position and articulated with the sacrum, and thus give a very clear conception of the superior aspect, as shown in figure 5. The ilium is elongate antero-posteriorly and very narrow vertically. In the latter particular it is relatively narrower than the most depressed type of ilia found in the genus *Camptosaurus*. Among American dinosaurs it most closely resembles the ilium of *Thescelosaurus*[17] from the Upper Cretaceous. Its upper plate-like extension rises very little above the level of the attached diapophyses from the sacrals, whereas in *Camptosaurus* it is everywhere high above these processes. Viewed from above (See fig. 5) the articulated ilia approach one another closest opposite the second sacral. Anteriorly the long pointed preacetabular processes are strongly divergent; posteriorly their divergence is more gradual, but the total width considerably exceeds the anterior end. On the inner side, behind the acetabulum, a relatively thin but wide shelf of bone is given off at right angles to the main portion of the ilium and articulates along its inner margin with the ribs of the two posterior sacral vertebræ. Viewed from above the shelf is V-shaped and unusually wide, the vertical plate of the ilium at the posterior end rises only 6 mm. above the level of the superior surface of the horizontal plate. The posterior termination of the right ilium, external to the shelf, is bluntly pointed.

These ilia clearly show the restored ilium of *Dryosaurus* by Marsh to be too deep and plate-like above, and posterior to the acetabulum. This same criticism is also probably applicable to his restoration of the ilium of *Laosaurus consors*.[18]

The right ilium measures 340 mm. from end to end. A lateral view of the restored ilium is shown in figure 6. The articulated ilia have a greatest

FIG. 6. Right ilium, vertebræ, and ossified tendons of *Dryosaurus altus* Marsh (No. 3,392, C. M. Cat. Vert. Foss.). Lateral view. One-sixth natural size.

[17] Proc. U. S. Nat. Mus., vol. 49, 1915, p. 607.

[18] Marsh, O. C., Dinosaurs of North America, 16th Ann. Rept., U. S. Geol. Surv., pt. 1, 1896, pl. 55, figs. 3 and 4.

expanse anteriorly of 165 mm.; at the middle 100 mm., posteriorly, estimated, 240 mm.

The left prepubis (See figure 5) lacks the anterior end and practically all of the slender postpubic portion. It is especially unfortunate that the anterior extremity is missing, for it cannot be determined whether the end was bluntly rounded, or whether it was squarely truncated; but it is quite apparent that the termination could not have been sharply pointed, as figured by Marsh in *Laosaurus*. It is this character which most definitely separates *Dryosaurus* from *Laosaurus* at the present time. The upper border of this bone is thickened and rounded, the lower being thin and sharp. The pubic foramen is closed as in the type. The larger size, narrow blade, and absence of a pointed extremity definitely distinguishes this prepubis from the short, tapering, sharply pointed prepubis of *Laosaurus*.

The proximal fourth of the right femur has been entirely extracted from the matrix and is in a fine state of preservation. In general aspect it closely resembles the femur of *Camptosaurus*, the only outstanding difference being the thickened and much heavier lesser trochanter, as contrasted with the compressed blade-like process in that genus. The greatest transverse diameter of the proximal end measures 80 millimeters.

The *pes* is represented by one nearly complete lateral metatarsal and the distal halves of two others of the right foot. The articulated left foot with a portion of the limb still remains unprepared in a block of matrix. These show the foot to be especially elongated and slender as compared with *Camptosaurus*. Metatarsal II has a greatest length of 163 mm.; the proximal end is compressed transversely, but wide antero-posteriorly. The proximal end is distinctly concave antero-posteriorly. The distal portion of the shaft shows no flattened appositional surface and was probably not closely applied to metatarsal III. The distal end is also transversely compressed with a prominent articular surface for the toe, which faces obliquely outward and downward.

Metatarsal III has a distinctly grooved distal articular end. It is the heaviest and probably the longest bone of the foot. The left element shows it to have a greatest length of about 170 millimeters.

Metatarsal IV is compressed transversely, with a decided flattening of the inner surface for close articulation with the median metatarsal. It would appear from these bones that the lateral elements in the articulated foot, as illustrated by Marsh,[19] are too widely divergent at their distal extremities.

[19] 16th Ann. Rept. U. S. Geol. Surv., pt. 1, 1896, pl. 55, fig. 4.

Part III. On a Skeleton of Laosaurus gracilis Marsh.

A third specimen in the Carnegie Museum, consisting of a badly crushed skull and partly articulated skeleton of a diminutive bipedal dinosaur, is provisionally identified as pertaining to the little known species, *Laosaurus gracilis* Marsh. Its tentative identification is due to my inability to compare it directly with the type specimen in the Yale Museum, which is necessary on account of the very meager original description, and from the fact that no part of the type of the species has ever been illustrated.

Marsh proposed three species under this genus: *Laosaurus celer*, *L. gracilis*, and *L. consors*. About the only distinguishing feature given by him for their separation is that of size. *Laosaurus consors* is the largest and best established, because of his illustration of a tooth and the articulated pelvis, hind limb, and foot.[20] In a later publication[21] a complete skeletal restoration of this species was published. *L. celer*, the genotype, is of intermediate size, and *L. gracilis* is the smallest. Whether all three represent valid species, or not, must await a restudy of the type specimens. The genus *Laosaurus* is well established, and should it be shown, as previously suggested, that *Dryosaurus* is congeneric, *Laosaurus* would stand on the ground of priority.

That the present specimen is referable to *Laosaurus gracilis* seems to be indicated by its very small size; by a scapula and coracoid, which resemble those of *L. consors* figured by Marsh; and posterior dorsal vertebræ, which agree closely with the measurements given of a "lumbar" of the type specimen.

The Ornithopod affinities of this specimen are abundantly shown by the skull, with a supraorbital fossa; a maxillary fossa or foramen; quadrate, jugal, and lower jaw of characteristic shape and proportions; the presence of curved femora with pendant fourth trochanter; and the presence of the unmistakable pectoral girdle of this group.

The original description given below constitutes practically all that has been written descriptive of this species, and, if the specimen in the Carnegie Museum is correctly referred, it constitutes a most welcome contribution to a better understanding of this species.

Laosaurus gracilis Marsh.

Laosaurus gracilis Marsh, Amer. Jour. Sci., vol. 15, 1878, p. 244.

The original description is as follows:

"A second species much smaller than the above [*Laosaurus celer*] is

[20] Amer. Jour. Sci. (3) vol. 18, 1894, pl. v, fig. 4.

[21] 16th Ann. Rept. U. S. Geol. Surv., pt. 1, 1896, pl. 57.

represented by well preserved remains of various parts of the skeleton. Its size is indicated by the following measurements:

Length of lumbar vertebræ	16 mm.
Transverse diameter of anterior end	18 mm.
Transverse diameter of posterior end	17 mm.
Length of median caudal vertebræ	16 mm.
Transverse diameter anterior face	12 mm.
Greatest diameter of proximal end of ulna	17 mm.

This reptile is the smallest known dinosaur with the exception of the diminutive species of *Nanosaurus* (*N. agilis* and *N. victor*)."

Description of Specimen No. 11,340, C. M. Cat. Vert. Foss.

The specimen consists of a badly crushed skull and lower jaws, articulated with the first three or four vertebræ of the neck, the latter still enveloped by the refractory matrix. Originally, I am informed, these cervical vertebræ were in sequence with the remaining part of the vertebral column preserved in a separate block of sandstone, but the contact has now been lost. The second series begins in the median cervical region and is apparently continuous posterior to, and including, one or more sacral vertebræ. The anterior dorsal region is hidden by the nearly perfect pectoral arch with both humeri in position. Posterior to the arch the column has suffered distortion and partial loss of centra, so that it cannot be determined whether the presacral series is complete or not. In the rock at the posterior end of the vertebral column are a number of fragments of bone, which may represent the pelvic bones, though none could be positively identified as such. In addition the hind limbs are represented by the distal portions of both femora and the proximal ends of the articulated tibia and fibula of the left limb.

The skeleton lay upon its back with ribs and fore limbs widely distended. It has been partially worked out in relief from this side and consequently, with the exception of those bones completely freed from the matrix, only the vertebral centra and a few ribs are to be observed in ventral view.

The short time at my disposal did not permit of the complete preparation of this specimen, but, in view of the rarity of *Laosaurus* remains, it was thought advisable to prepare a preliminary description, in order to make immediately available to students of the Dinosauria such information as was furnished by the skull and pectoral arch, with brief mention of such other structural features as may be observed in its present unprepared condition.

The Skull:—The skull of No. 11, 340, C. M. Cat. Vert. Foss., is so badly crushed and misshapen, that in the attempted restoration, shown in figure 7, there is much left to conjecture in so far as its natural profile is concerned. The general

structure and shape of the skull appear very close to the cranium of *Dryosaurus* previously described, as may be seen by comparing figures 3 and 7, the greater depression of the nasal region being the one outstanding difference. This bending down of the nasals in front of the orbits gives the muzzle a bluntly wedged-shaped appearance, which is undoubtedly exaggerated in the original by crushing. The nose of the skull has been pinched off and is missing.

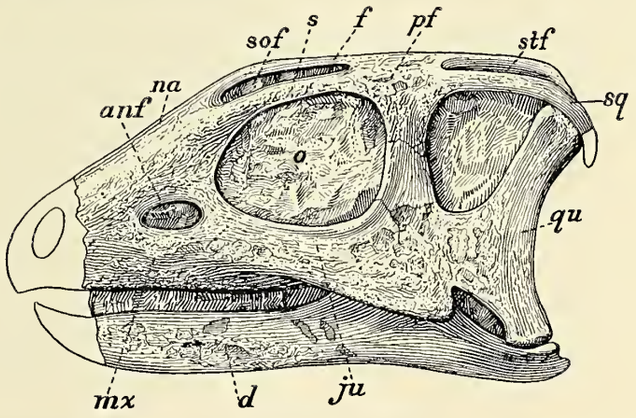


FIG. 7. Reconstructed skull of *Laosaurus gracilis* Marsh (No. 11,340 C. M. Cat. Vert. Foss.) Viewed from the left side, about natural size. *anf*, anteorbital fossa; *d*, dentary; *f*, frontal; *ju*, jugal; *mx*, maxillary; *na*, nasal; *o*, orbit; *pf*, postfrontal+postorbital complex; *qu*, quadrate; *s*, supraorbital; *stf*, infratemporal fossa; *sof*, supraorbital fossa; *sq*, squamosal; unshaded portions indicate restoration of parts not present in the fossil.

On the left side a slender supraorbital bar clearly forms the outer boundary of the elongated supraorbital fossa as in *Dryosaurus*. It is relatively slenderer than in that genus. The orbits are large, with a greater diameter antero-posteriorly than vertically. On the right side the complete quadrate is present and articulated below with the lower mandible. Its upper extremity is capped by a remnant of the squamosal. It is strongly curved from end to end as in *Camptosaurus*.

As preserved, the quadrate is in close contact anteriorly with the postorbital bar and the wide triangular plate-like jugal, but it would seem that on this side the whole postorbital bar has been crushed backward against the quadrate, thus entirely obscuring the outlines of the infratemporal fossa from a lateral view. That this fossa is present is clearly indicated on the opposite side, where the complete postorbital bar remains in natural position and behind it the anterior outline of the fossa is clearly discernible.

The postorbital+postfrontal probably forms a complex, as in *Camptosaurus* and *Dryosaurus*, at least no sutural separation of these elements can be detected.

The ventral position of this complex forms a flattened, moderately wide bar, which extends downward to join the jugal. The jugal, especially on the right side, is fairly complete. It is narrow below the middle of the orbit, but posteriorly widens rapidly, forming a subtriangular plate, the apex of which is directed downward and backward.

The maxillary bone is perforated by a small elongated foramen, or anteorbital fossa, which lies wholly within the maxillary, as in the skull of *Dryosaurus*. The frontal region is broad and flat. Between the inner borders of the supraorbital fossa the frontals have a greatest transverse extent of 28 mm. The parietal region is so badly crushed and broken that its details are obscured. The nasals are wide posteriorly, and turn strongly downward from their union with the frontals. Their median suture is distinct. The superior surfaces of the conjoined nasals appear to be decidedly concave for a considerable distance along their median junction.

None of the detailed features of the lower mandible are to be observed. In general outline, so far as preserved, it resembles the lower jaw of *Dryosaurus*.

Measurements.

Greatest length of skull, estimated	82 mm.
Greatest height of skull with ramus, posterior end	47 mm.
Greatest height of skull with ramus, center of orbit	34 mm.
Antero-posterior diameter of orbit	22 mm.
Vertical diameter of orbit	17 mm.
Antero-posterior diameter of supraorbital fossa	20 mm.
Length of quadrate	33 mm.

Vertebræ:—The vertebral centra in their general ventral aspect closely resemble those of the articulated skeleton of *Camptosaurus medius*, except for their very much smaller size. The cervical centra have the median lateral surfaces pinched in, forming lateral depressions; the capitular facets on the anterior lateral sides widen the forward end, and ventrally there is an angular keel which widens at either end. Posteriorly the transverse constriction of the centra becomes less and less, so that in the posterior dorsal region they become broadly rounded. The whole vertebral column, when viewed from below, grows gradually heavier and stronger posteriorly, reaching its maximum development in the anterior sacral region. In the present condition of the specimen there is little more to be said of the vertebral column. If the last complete centrum is correctly identified as being the sacro-dorsal, it is estimated that the complete presacral series would have a total length of about 315 mm. or about 12 inches.

The close agreement in the dimensions as given below of the most posterior centrum of the present specimen to the so-called "lumbar" of the type of *L. gracilis* apparently indicates the correctness of its reference to that species.

	Type of *L. gracilis*	No. 11,340 Carnegie Mus.
	mm.	mm.
Length of centra	16	14
Transverse diameter, anterior end	18	16
Transverse diameter, posterior end	17	14.5

Hind Limbs:—The left femur, which lacks its proximal third, has a curved shaft, as in the other members of the family *Laosauridæ*. On the inner hind margin of the shaft a compressed fourth trochanter of the pendant type is developed. The inner condyle is robust with a decided projection backward. There is a shallow anterior intercondylar groove as in *Camptosaurus*. The greatest transverse diameter of the distal end is 27 mm.

The articulated proximal ends of the left tibia and fibula resemble the corresponding parts in *Camptosaurus*. This end of the tibia has a greatest diameter of 21 mm.; the fibula measures 15 mm.

The limb bones are hollow, but have thickened walls.

It is estimated that the complete length of this animal would not have exceeded two and one-half feet, with an estimated height at the hips of about 12 inches.

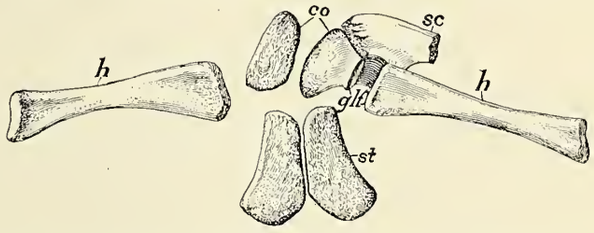


FIG. 8. Pectoral arch and humeri of *Laosaurus gracilis* (No. 11,340, C. M. Cat. Vert. Foss.) ventral view. About one-half natural size. *co*, coracoid; *glf*, glenoid fossa; *h*, humerus; *sc*, scapula; *st*, sternal plates.

Pectoral Arch and Fore Limb:—The pectoral arch in specimen No. 11,340, C. M. Cat. Vert. Foss. is in an especially fine state of preservation, showing clearly for the first time the relative relationships of these bones in the *Laosauridæ*. The scapulæ lie in nearly normal position in relation to the back-bone, with the articulated coracoids turned in to meet in close apposition along the median line. The right scapula has a greatest length of 78 mm. Immediately posterior to them are the relatively large paired sternal plates, and on either side, with the proximal ends but slightly withdrawn from the glenoid fossa the complete humeri extend outward at right angles (See figure 8).

Humerus:—The humerus in *Laosaurus* is slender and but little expanded at distal and proximal ends. These bones are relatively straighter than in *Camptosaurus*, with deltoid crest but feebly developed, condyles ill defined, and with head but slightly indicated. It appears to differ from *Camptosaurus* in having the greatest diameter of the proximal and distal ends in the same plane, whereas in *Camptosaurus* they are twisted so as to be at a slight angle to one another.

The distal end is obliquely truncated, as in *Dryosaurus*, and to a less degree in *Camptosaurus*.

Measurements.

	Right	Left
Greatest length of humerus	61 mm.	63 mm.
Greatest width of proximal end	14 mm.	14 mm.
Greatest width of distal end	11 mm.	12 mm.

Sternal Plates:—One of the interesting features of the present specimen is the presence of ossified sternal plates (See figure 8). In the characterization of the genus *Laosaurus* Marsh definitely states "sternum unossified," which statement this specimen now demonstrates to be an error. Furthermore, now that osseous sternal plates have been found in *Laosaurus*, *Monoclonius*, *Triceratops*, *Thespesius*, *Stegosaurus*, and *Thescelosaurus*, it may be expected that these elements will eventually be found in all predentate dinosaurs.

In specimen No. 11,340, C. M. Cat. Vert. Foss., it is especially fortunate that these bones have been so preserved that they not only show their proper mutual relationships, but also their actual positions in relation to the rest of the pectoral girdle, as clearly indicated in figure 8.

The sternum of *Laosaurus*, except for its very much smaller size, exhibits a striking similarity in form to that of *Monoclonius*.[22] It consists of two long flat plates each having a thick external and a thin internal border. The anterior end is thickened, especially on the external side, for articulation with the coracoid; the wider distal end seems to be thin. Indentures for the attachment of the cartilaginous sternal ribs have not been observed.

These plates have a greatest length of 24 mm. At the anterior end these articulated bones have a greatest transverse diameter of 22 mm.; breadth of the posterior ends 28 mm.

The evidence furnished by this specimen as to the proper articulation of the sternal plates, shows quite conclusively that these bones are reversed in the mounted skeleton of *Diplodocus* in the Carnegie Museum. The articulated pectoral arch of this specimen has been illustrated by Holland,[23] who at that time expressed

[22] Brown, B., Bull. Amer. Mus., vol. 37, 1917, pp. 291–292, figs. 3 and 4.

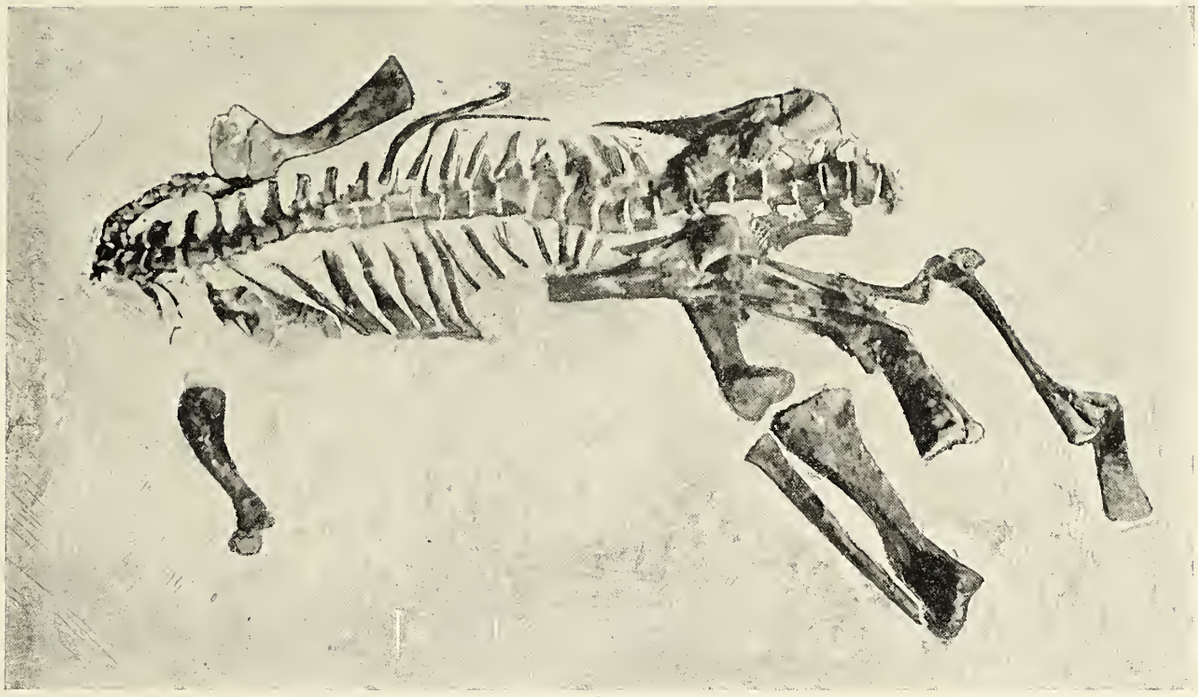
[23] Holland, W. J., Memoirs of the Carnegie Museum, Vol. II, no. 6, 1906, p. 257, fig. 25.

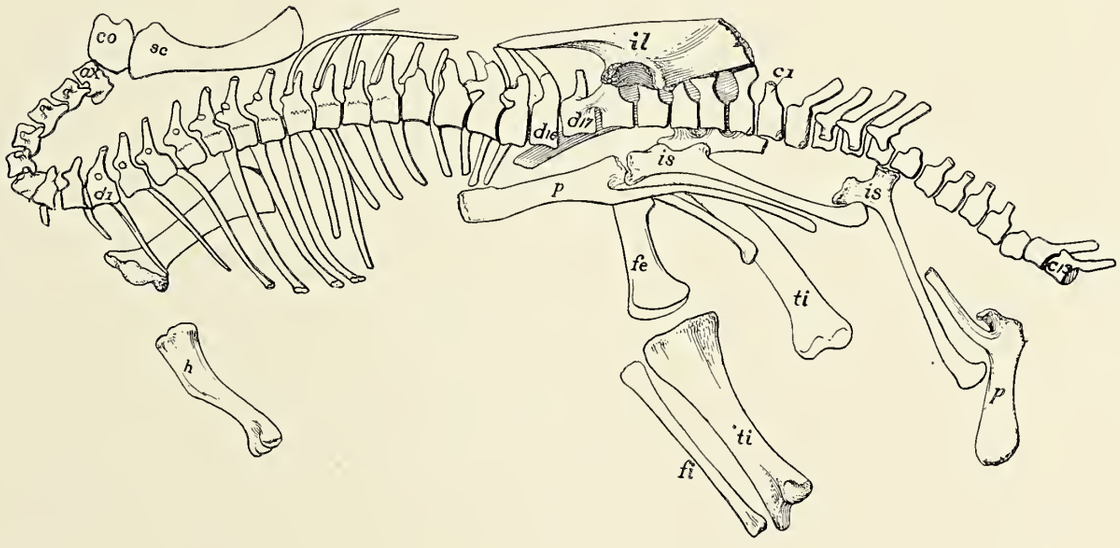
doubt as to the correctness of their articulation, and it was after much study that the decision was reached that the narrowed but thickened extremities represented the border best suited for the attachment of the cartilaginous ribs. In the absence of definite evidence at that time, this decision represented a most natural conclusion. In the paper cited above Holland calls attention to the fact that Marsh in his "Dinosaurs of North America," plate XXII, figure 1, represents the sternal plates of *Brontosaurus* one way, and in the same publication on page 179, figure 30, those of *Morosaurus* in an opposite direction. From the evidence now at hand it is very evident that the position of the plates in *Brontosaurus* is correct, and that those of *Morosaurus* have been reversed and therefore erroneously placed by Marsh.

EXPLANATION OF PLATE XVIII.

Upper Figure: Skeleton of *Camptosaurus medius* Marsh (No. 11,337, C. M. Cat. Vert. Foss.), viewed from the left side, showing the position of the bones of the skeleton as now prepared for exhibition. One block containing caudal vertebræ and another carrying left fore limb and foot did not lend themselves to photography and are not shown in this figure. One-eleventh natural size. Reproduced from a photograph by A. S. Coggeshall.

Lower Figure: Outline of the skeleton of *Camptosaurus medius* Marsh. Designed as a key to the upper figure. One-eleventh natural size. *ax*, axis; *c*1, and *c*13, caudals 1 and 13 respectively; *d*1, first dorsal; *d*16, sixteenth dorsal; *d*17, last presacral, or lumbar vertebra; *fe*, femur; *fi*, fibula; *h*, humerus; *il*, ilium; *is*, ischium; *p*, pubis; *sc*, scapula; *ti*, tibia.

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